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Revival of the rice crops in the south of Romania: Pros and cons

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Abstract

In Europe, the rice is presently cultivated on small areas. The south of Romania is one of the regions with tradition in rice agriculture, as the paddies are located at the northern rim of its European belt. The aim of the study is to bring arguments for the benefits of reviving the rice paddies in the Danube and its major tributaries floodplains, which are suitable for such kind of farming. The research methodology was based on direct field survey, map interpretation, diachronic analysis (1950-2014) and survey (semi-structured interview). Results have shown that a decay period in rice farming had occurred during 1990 to 2006 because of the misapplication of the agrarian policies in the rice-based agricultural societies. After 2006, a slight revival of the rice paddies has occurred in the south of Romania, with the help brought by foreign investors on the Romanian of the rice market. At the same time, a conflicting perception of the target groups on both the advantages and disadvantages of this process has been found: 75% pros and 25% cons. Economic and environmental advantages - new jobs, increasing income by collecting additional taxes, protecting biodiversity, and connection with Natura 2000 network - were argued by the local authorities, engineers and partially by farmers. On the other hand, the remaining farmers are against the revival of rice crops, alleging the reduction of grazing land. Among the environmental disadvantages, the high water demand for irrigations, use of herbicides, and methane release in the atmosphere are the most destructive.

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Keywords: rice; field; water; floodplain; economic; environmental; Romania

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1. Introduction

Rice is not commonly a major crop in Europe, but its consumption has constantly been increasing in European countries during the last years. The production costs of rice in Europe are quite high comparing to those in the large Asian rice producing states. In Europe, rice paddy fields are sparse and compared to Asia cover a small area in total (580,000 hectares). Among the traditional rice-producing states there are Italy, Spain, Greece, Romania, France, Portugal, Bulgaria, Hungary, Albany, Ukraine, Russia and Republic of Macedonia [1,2]. The intensive cultivation of rice is typical to northern Italy, in the provinces located long the Po River. The core of Italian rice province (Lombardian-Piemontan) is represented by the town of Vercelli [3]. The most extensive rice fields in the Iberian Peninsula are located in Andalusia, Murcia, and Ebro basin [4], and in Greece in Central Macedonia (Thessaloniki), Imathia şi Pieria [5].

The problem of intensive rice crops is quite sensitive for the 21st century, even for Europe, which is not one of the major rice producing area on the global markets. Therefore, the following question arose: *Is there a scientific consensus on the relationship between agriculture and environmental impact in the intensive rice farms?*

Academic brought both pros and cons, about the impact of these crops on the environment. The following ecosystem services of rice paddy fields were mentioned among the pros: biodiversity (birds, fish, snails, snakes, insects, butterflies, etc.), groundwater recharge, flood buffer, moderating local air temperature [6], preventing soil erosion, cultural aspects related to the preservation of traditional rice landscapes, etc. [7, 1]. The chemicals used in intensive rice crops, pesticides and herbicides respectively, then the methane emissions from rice fields in the atmosphere were discussed among the arguments against, with a negative impact on the environment and biodiversity [8, 9, 10, 11]. However, 2004 was declared the International Year of Rice by FAO [12, 13].

In addition to the environmental problems caused by these crops, economic benefits should be considered, as rice fields provide much of the food needs of humanity. Moreover, given that food resources should meet the demand of the world's current population growth rate, some specialists advanced the idea that increasing rice productivity wherever possible is the least costly mean to achieve this aim [9]. Under these circumstances, a small part of the agricultural land in south-western and southern Romanian is suitable for rice cultivation, and has began to revive in this respect.

The purpose of the study lies in the argumentation for the recovery of rice fields in the meadows of Danube Valley and its tributaries, which lend to such crops. The main objectives are: to identify and inventory both the old (abandoned) and rehabilitated (current) rice fields, and to analyze local communities' perception/consciousness on the recovery of rice facilities in the two study areas (Dăneasa and Stăncuța). This analysis is welcome given that the involvement of local communities in decision making in matters affecting them has increased lately, with the transition to capitalism.

Study area

In order to achieve the main goal of the paper, we made a two-scale analysis. The spatial analysis of the whole rice-cultivated area included the Danube's and its major tributaries' (Jiu, Olt, Ialomiţa, and Siret) floodplains in the Romanian Plain (Fig. 1). This area is vast, given that the land suitable for rice growing in Romania is considerably sparse.

For the perception analysis, two communes in the specified area were selected: Dăneasa (in Olt County), and Stăncuța (in Brăila County). Dăneasa is located in the Olt river floodplain, in the Olt County, whereas Stăncuța is in the Danube's floodplain, within the largest rice facility in Romania: Călmăţui-Gropeni. The selection was based on the following criteria: a) both hold large, well-represented rice-cultivated areas; b) both were rehabilitated after the 2000 by the foreign (Italian) investors; c) they are located in two different lowland areas. The rice fields within these two communes occupy large areas, compared to other poorly rice-cultivated lands in the study area, which have never been rehabilitated and have a rather insignificant role for the local communities.

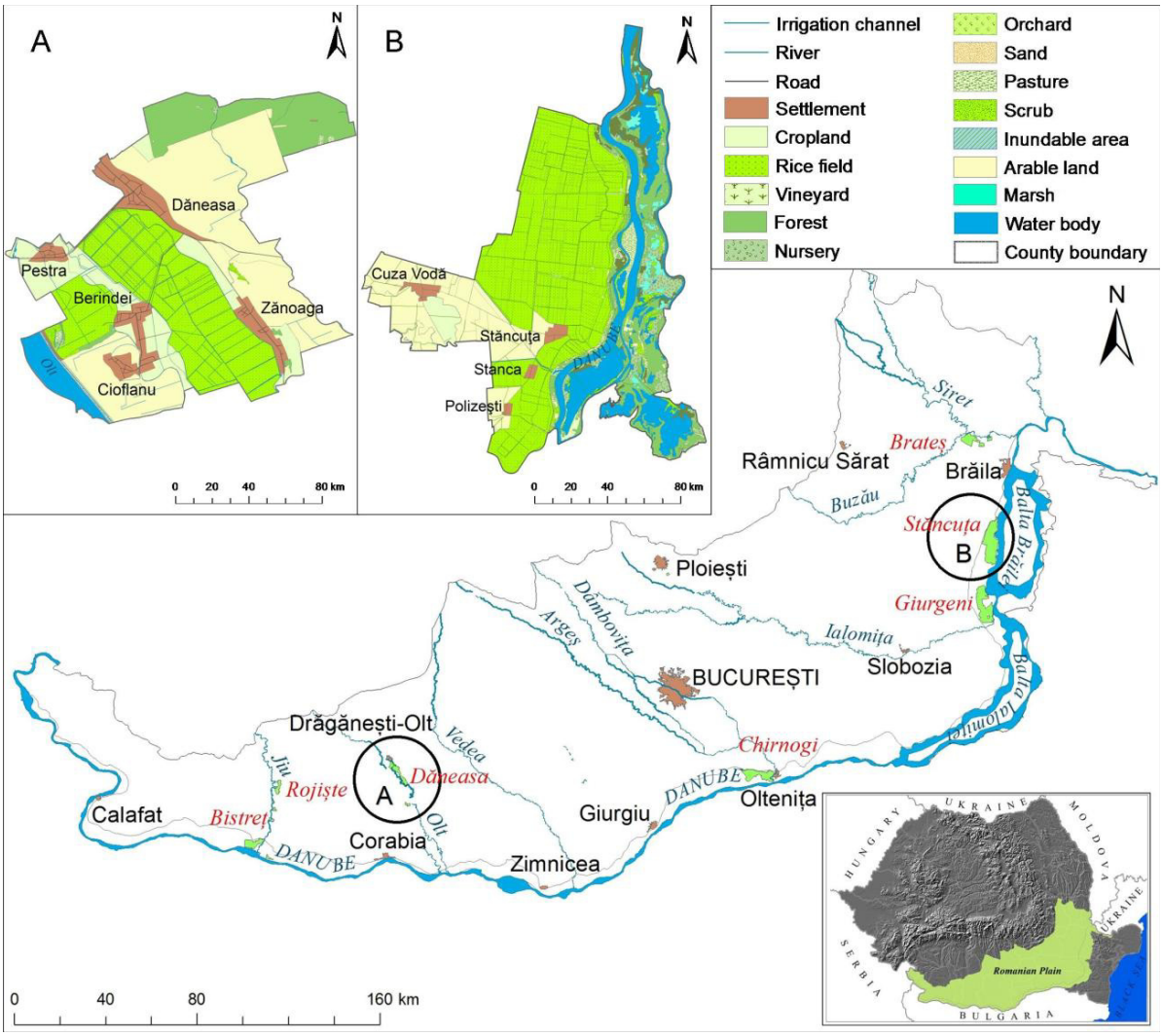

Fig. 1. Geographic setting of Dăneasa (A) and Stăncuța (B) communes within the Romanian Plain. The names of major rice paddy fields in Romania were written in red.

2. Methodology

The main research methods used for this study were: field observations, diachronic analysis using GIS techniques, and survey (semi-structured interview) using Nvivo 11 software, a quality assessment tool.

The field survey consisted in successive campaigns during the period June 2014-July 2015 in the study area, completed with a set of observation sheets both on former rice fields, and the currently restored paddy fields by the Italian investors. Using the diachronic analysis we quantified the temporal changes of the rice fields in the south of Romania. Thus, the digital mapping tools and techniques helped to identify and vectorize the former and current rice fields on topographic maps for the period 1950-1990 and orthophotographs for 2006. For mapping and analysis of the rice fields in 2014 we used Google Earth satellite imagery (courtesy of Digital Globe). The results were afterwards validated by field survey. During the next field campaigns (August-October 2015), a series of individual and group semi-structured interviews were applied in Dăneasa (Olt County) and Stăncuța (Brăila County) villages, in order to assess the perception of local communities on the revival of rice paddies in the area.

The target group included several social-professional categories. In fact, we used a rationale-based sampling procedure, applied on 12 respondents. This is a convenient sample according to social science research methodology, which gives a number of respondents between 12 and 60 [14] or at least 6 [15], depending on data saturation. To ensure anonymity and ease of use in NVivo each respondent was assigned a code [16, 17, 18, 19]: local authorities (mayors - M1, M2), agronomists (E1, E2), locals (individual farmers - livestock farmers and landowners, '*vadagii*' – meaning workers on paddies, F1 to F4), representatives of foreign investors (i.e. Italian, this case) in the area (D1, D2), and specialists of the National Agency for Environmental Protection in Brăila and Olt Counties (I1, I2).

The questions from the interview guide included the following issues: the economic role of local rice fields, benefits and environmental damage triggered by the rice fields' redevelopment, environmental conflicts arising from conversion of agricultural land (e.g. pasture to paddy fields), etc. The interviews were analyzed using the Nvivo 11 software; respondents' answers were coded (by creating nodes) by profession, gender and age. The next step was data mining by querying the frequency of words and keyword search. Thus, the words cloud was generated in the form of two types of graphs: actual words cloud and tree map, which allowed us to order the importance of the issues raised in the study through the perceptions of respondents. To study the matching and divergence of standpoints on the selected sample, a cluster diagram (or dendrogram) based on Pearson's correlation coefficient was performed [20]. This coefficient a statistical measure of the strength of a linear relationship between paired data, X and Y. The computational formula for the Pearson's coefficient is very complicated, but is given below in a simplified form [21]:

$$r = \frac{N(\Sigma XY) - (\Sigma X)(\Sigma Y)}{\sqrt{[N(\Sigma X^2) - (\Sigma X)^2][N(Y^2) - (\Sigma Y)^2]}}$$

The value of Pearson's correlation coefficient is constrained as follows:

$$-1 \leq r \geq 1,$$

where r is the Pearson coefficient[22].

Using word similarity by nodes, the Nvivo software has created rows for nodes, columns for each different word which appears in the text of the nodes, and cells with the number of times the column's word appears in the row's node. After that, the application calculated a similarity index between each pair of items (each pair of rows in the table) using the similarity metric by Pearson's correlation coefficient. The maximum value of Pearson's coefficient (1) shows a strong positive correlation of the values. The analysis is displayed as a dendrogram, with similar items clustered together on the same branch, and different items are further apart.

3. Results and discussions

In the Romanian principalities, the cultivation of rice was introduced in 1786 by Italians in Banloc (Banat province), in the floodplain of Bârzava river [23]. Subsequently, other rice fields have occurred in Danube's and its tributaries floodplains in the Romanian (Wallachian) Plain [24]. The landscaped rice fields in Romania are located at the northern limit of the rice crop in Europe [2].

3.1. The diachronic analysis

The diachronic analysis on rice cultivation in Romania was performed for the period 1950-2014 (Table 1). Thus, there was a considerable increase of the rice-cultivated areas in southern Romania (Danube's floodplain and the riparian meadows of its tributary rivers - Jiu, Olt, Ialomița and Siret) for the period 1950-1990 (Fig. 2a).

Between 1990-2000 the rice crop has experienced a strong setback because most of the rice facilities were destroyed (decommissioned). After 1990, the application of the Land Law no. 18/1991, they were dismantled and divided into hundreds of plots, which were returned to their former owners. The same thing happened with the rest of farmlands in Romania [25]. In other words, we can say that this period of transition to a market economy was characterized by the misapplication of agricultural policies in the agricultural companies specialized in rice culture.

Thus, it was their bankruptcy and liquidation, although under the communism significant investments in facilities had been made and there was a consistent specialized manpower in this field (e.g. specialists, workers). The destruction of irrigation-drainage systems and lack of the timely mandatory technology, as well as the poor management are just some of the factors that led to a gradual degradation of rice facilities in Romania.

Table 1. Dynamics of the rice-cultivated land in the south of Romania during 1950-2014

Year	1950	1960	1980	1990	2006	2014
Area (ha)	68,633.69	46,789.05	43,570.95	32,364.04	5,186.90	28,766.03

Source of data: extracted from the attribute tables of the layers created in ArcMap.

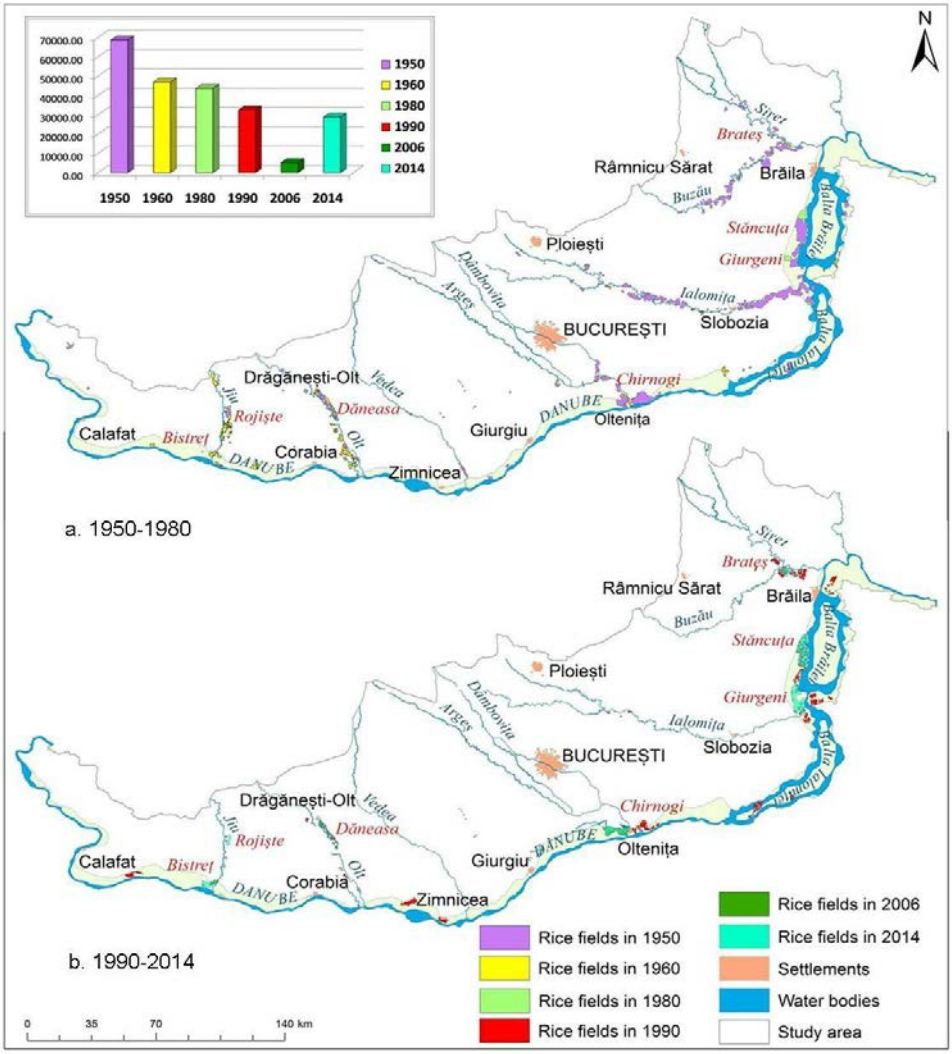

Fig. 2. Dynamics of the rice fields during 1950-2014 (a, b). Notice the high gap recorded in 2006, and the revival in 2014 on the graph.

Given that these land areas arranged as paddy fields were less fertile to other crops, after 1990 they have been converted to grassland (communal meadows) or became barren land (fallows or fallow plots). After 2006 there was a slight revival of the rice culture, with the entry of foreign investors on the Romanian market (Fig. 2b). The Italian Riso Scotti, headquartered in the city of Pavia (Italy), has implemented an investment strategy called Danube project

(Progetto Danubio), through which it aimed the restoration of the communist rice facilities abandoned in the 1990s in the south of Romania [26]. For example, the rice fields in Dăneasa and Stăncuţa have been rehabilitated by the Italian investors, who rebuilt the infrastructure (e.g. irrigation canals and systems, dams, pumping and drainage stations) and introduced the latest generation working machines.

Out of the total suitable land for setting rice paddies purchased in 2007 by the Riso Scotti group in Romania (7,500 hectares), an area of 3,700 ha was planted with rice, distributed as it follows: 2000 ha in Ialomiţa County, 700 ha in Brăila County and 1,000 ha in Olt County [27].

The values of rice-cultivated areas for the analyzed years are shown in Table 1 and illustrated in Fig. 2. It is considered that the existing paddies in 1950 represent the maximum area for the entire analyzed period (1950-2014) according to the graphic. By interpreting the values, we can deduce the following:

1) In the period 1950-1990 (corresponding to communist regime), the paddy fields in Romania recorded a continuous decline as a percentage of 47.16% of the initial value. However, their area was much more extended compared to the next intervals, including after the relaunching of this crop in Romania;

2) In the period 1990-2006 the downturn was strong amid land restitution to former owners by Law 18/1991. Thus, the rice fields came to an occupancy degree of just 7.56% of the initial value;

3) Since 2006 to 2014 a revival of the rice crop occurred in Romania due to Italian investments, and the paddy areas increased by about 5 times (554%) compared to 2006. This process is in full development at present, continuing to expand the areas occupied by rice fields. However, the percentage reached is much lower than the initial one (since the beginning of the reporting period 1950-1990), only 41.92%.

Table 2. Changes of the rice-cultivated areas in Dăneasa and Stăncuța (1990-2014)

Commune/Area (in hectares)	Total area	Rice fields in 1990	Rice fields in 2014
Dăneasa	5,688.15	1,767.12	1,996.32
Stăncuța	25,597.77	5,367.36	9,391.10

Source of data: extracted from the attribute tables of the layers created in ArcMap.

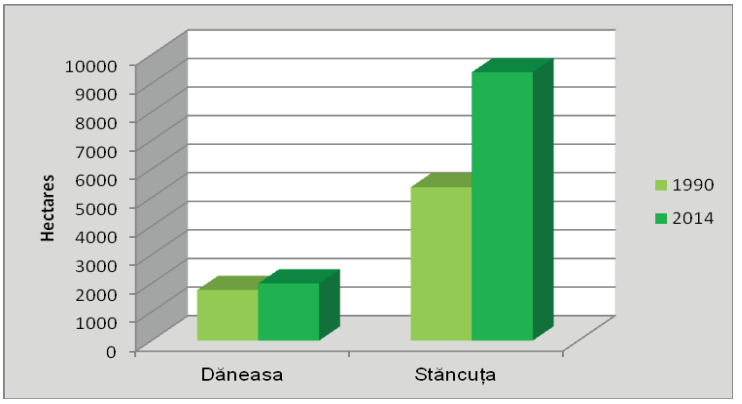

Fig. 3. Redevelopment of rice paddy fields in Dăneasa and Stăncuța in 1990 to 2014, inferred from the GIS mapping results.

In the two settlements analyzed as case studies, one can notice that the rice-cultivated areas have certainly increased in 1990-2014, the most relevant period for our analysis. This increase was of 4.3% in Dăneasa (from 31.07% of the total area in 1990 to 35.10% in 2014), and much higher in Stăncuța, 15.72% (from 20.97% in 1990 to 36.69% in 2014), compared to the total area of the communes (Fig. 3 and 4).

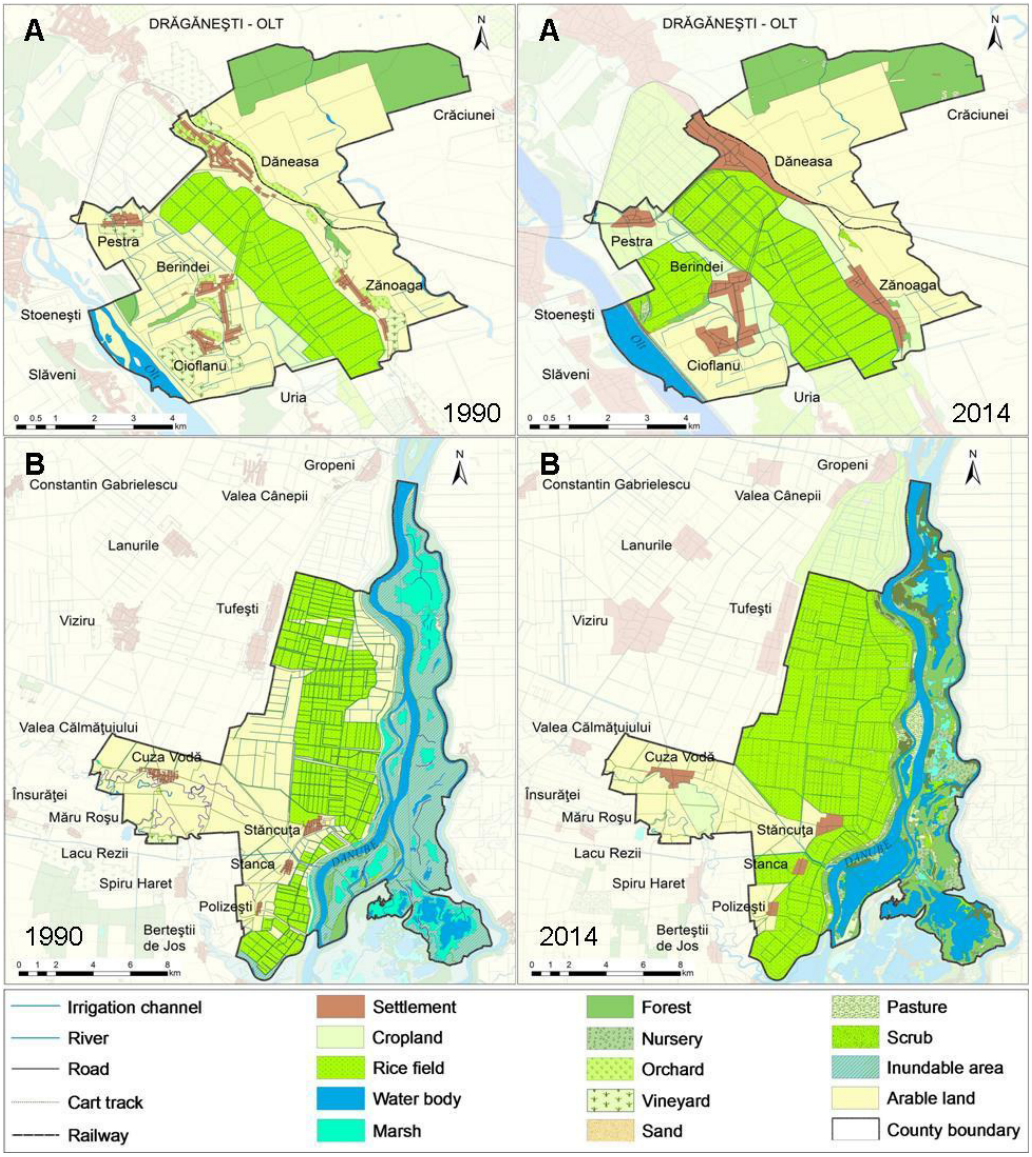

Fig. 4. Detailed maps showing the dynamics of the rice fields during 1990-2014 for each analyzed settlement: A. Dăneasa; B. Stăncuța. A slight opacity tool was applied to mask the areas of the neighboring communes.

3.2. Divergence and convergence in the perception of local actors on the rice fields

To study the impact of rice fields we applied an open-questions interview on 12 subjects, covering a range of specific activities of the two study areas (Fig. 5a,b). We found that for local community the rice-cultivated land is very important both economically and to achieve and maintain local biodiversity. The analysis of words cloud show that the most frequent words were *rice* (4.07%) and *paddy* (1.95%), followed by: *fields*, *disadvantages*, *water*, *crops*, *economic*, *irrigation*, *southern Romania*, *environmental*, *investors*, *degraded*, *fish*, etc. (Fig. 6). The frequency of such words may indicate that great emphasis was placed on the issues related to them. Interestingly, if taken out of context, the word ‘disadvantage’ could lead to the idea that these crops were rejected by respondents, although they (especially farmers) associated rice crops with reduced areas for grazing lands.

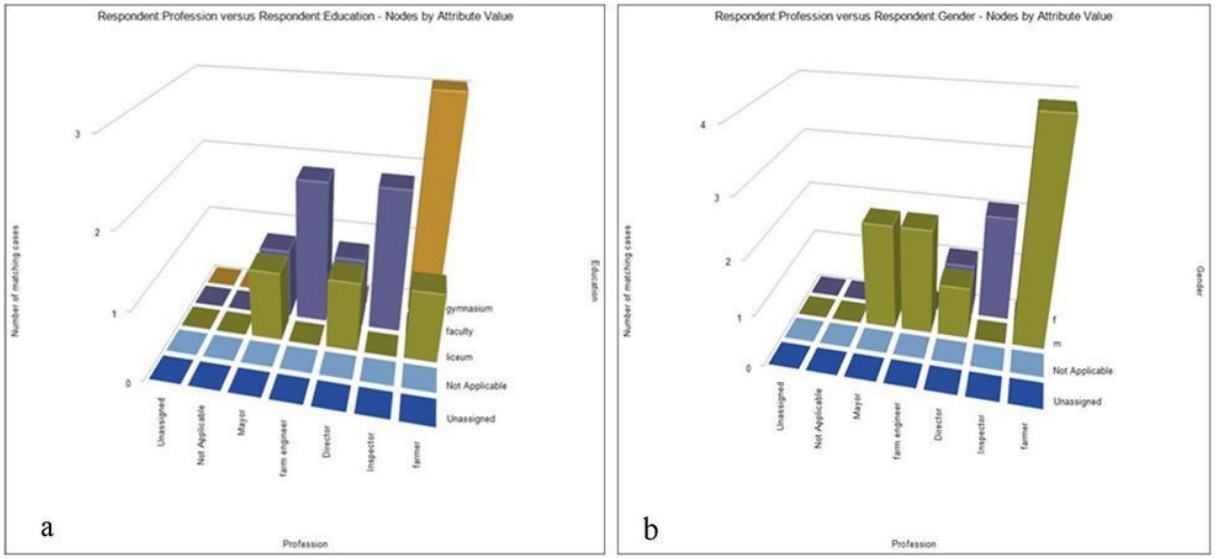

Fig. 5. Composed profile of the sample: a. profession-education; b. profession-gender (extracted from Nvivo 11 output).

Fig. 6. Words cloud (extracted from Nvivo 11 output).

The results of semi-structured interviews obtained after processing in Nvivo show a strong correlation (r = 1), illustrated below on the dendrograms in Fig. 7 and 8. Several contradictory aspects in terms of perception of local communities on the recovery of rice facilities were found, according to the parties involved (75% have answers pro paddy fields revival and 25% against). In both settlements, Dăneasa and Stăncuța, local authorities (mayors - M1, M2) believed that the resumption of rice culture is a welcome activity in several ways: increased revenue from taxes at city hall budget; creating new jobs locally (M1); restoring the current fallows as rice fields (M2), which was also mentioned by the representative of the Olt Environment Agency (I1); engineers agronomists (E1, E2) brought other arguments, such as: recovery of degraded (salty) meadow land, which do not lend themselves to other types of crops; the fact that rice is a safe culture that reacts positively to climate conditions typical to southern areas of Romania, some of which are subject to the aridity phenomenon. A heterogeneous group similarity was linked to economic benefit by reducing rice imports seen in Romania (D2, F2, E2). A disagree with the views of 'pro' of economic benefits from paddy fields is expressed by the group of farmers (F4, F1, F3) - Fig. 7a.

As for the economic disadvantage of reopening rice fields, profession and membership in the community

similarity generated ideas agglutination and contradictions between groups. The representatives of investors (D1, D2) have expressed dissatisfaction with the impossibility of acquiring new land for the expansion of paddies, because such land suitable for rice cultivation are currently used as pasture (degraded), and thus would conflict with breeders. It also noted that the Agency for Payments and Intervention in Agriculture (APIA) granted Romania a subsidy of 300 euro/ hectare of rice (2014), with a possible increase to 450 euro/ha in 2015 to the community where European subsidies are granted 850 euro/ ha. Local farmers (F1-F2), particularly livestock breeders (sheep, cattle, horses) were dissatisfied and considered that pasture areas have been gradually reduced because of rice crops recovery. This has generated a series of conflicts between rice growers and livestock farmers (shepherds), which allowed the animals to get, sometimes in rice crops. Interesting clusters are those made up of agronomist engineers (E1, E2), but also of environmental inspectors (I1, I2), claiming disadvantages of environmental costs, and rice fields executives (D1, D2) some constraints on economic fundamentals (Fig. 7b).

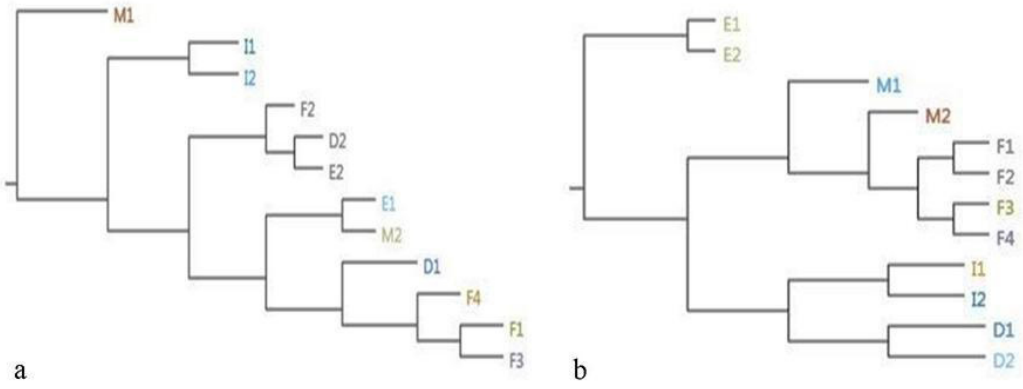

Fig. 7. Cluster dendrogram of economic advantages (a) and disadvantages (b). Source: Extracts from Nvivo 11 outputs.

Beyond the economic issues, in the current context of sustainable development, investigating perceptions of environmental issues is very helpful. The study reveals the advantage of increasing local biodiversity on paddy fields, which recorded a high convergence opinion (D1, D2, F1, F2, F3, I2, M1, and M2) (Fig. 8a). The interviewed Environmental Protection Agency representatives argued extensive environmental benefits by boosting rice crops (I1). This explains that in the absence of natural wetlands in some regions of southern Romania, waterfowl (e.g. herons, egrets, storks, wild ducks) attend *artificial wetlands* (*human-made wetlands* - under the Ramsar classification): irrigation channels, flooded rice fields, providing new habitat and compensating the decrease or loss of natural wetland areas. Therefore, paddy fields are becoming increasingly requested and used for parking aquatic fauna during the summer or migrations. It was also noted that the alluvial soils of the Danube Valley, and the Danube River adjacent meadows were subject to degradation and secondary salinization process. The only way to improvement and enhancement of these salty soils is the rice culture.

The analysis of climatic parameters from recent years shows an alternation of very rainy years with very dry years. Therefore, the controlled irrigation of rice fields in the Danube Valley would protect dammed enclosures from potential flooding [6]. Coating a layer of necessary water for the rice crop for a period of four to five months per year will sensitively alleviate daily temperature variation. On the other hand, water use has positive effects, namely water in paddy fields creates an ideal habitat for various species of birds, some of which are strictly protected. Thus, rice cultivation contributes to maintaining and even increasing biodiversity (Fig. 9). In saline areas, the flow of water in paddy fields lowers the salinity and prevents their impoverishment. Then, infiltration of paddy fields in the basement helps maintain groundwater at a good level and to maintain an efficient water management.

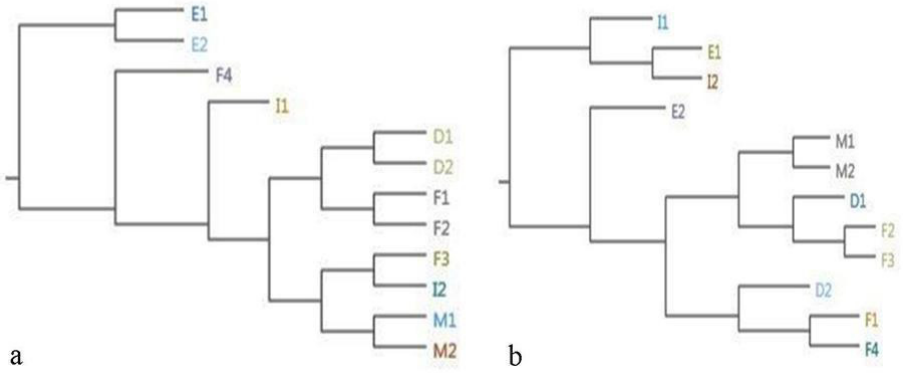

Fig. 8. Cluster dendrograms of environmental advantages (a) and disadvantages (b). Source: Extracts from Nvivo 11 outputs.

Fig. 9. The rice fields in Dăneasa, Olt County © I. Vijulie (2007, 2015).

As for the environmental disadvantages, the opinions are heterogeneous, with a clustering slightly divided on professions. Agronomist engineers and representatives of environmental agencies brought a series of arguments that explain some possible environmental disadvantages in the context of recovering rice crops. Among these they included: the application of environmentally friendly agro-technical works by using herbicides (I2) and pesticides (E1, I1), and increased water consumption for maintaining the rice fields (E2) (Fig. 8b). The high consumption of

water for rice irrigation can raise questions of water availability in certain areas of biological interest in the Natura 2000 network, which in southern Romania overlap mostly with these rice fields (Fig. 10).

Thus, in the rice-cultivated areas affected by drought in the south of Romania, the need for water may compete with other uses. Flood irrigation also promotes the proliferation of segetal plants (weeds), which requires an increased use of herbicides, residues of which pollute surface and ground water. Another risk to the environment is the emission of methane generated by rice into the atmosphere (I2). Much of the local community saw only the environmental benefits (M1, M2, F2, F3, D1) or said that they have no knowledge on the environmental disadvantages caused by the presence of rice fields (F1, F2) (Fig. 8b).

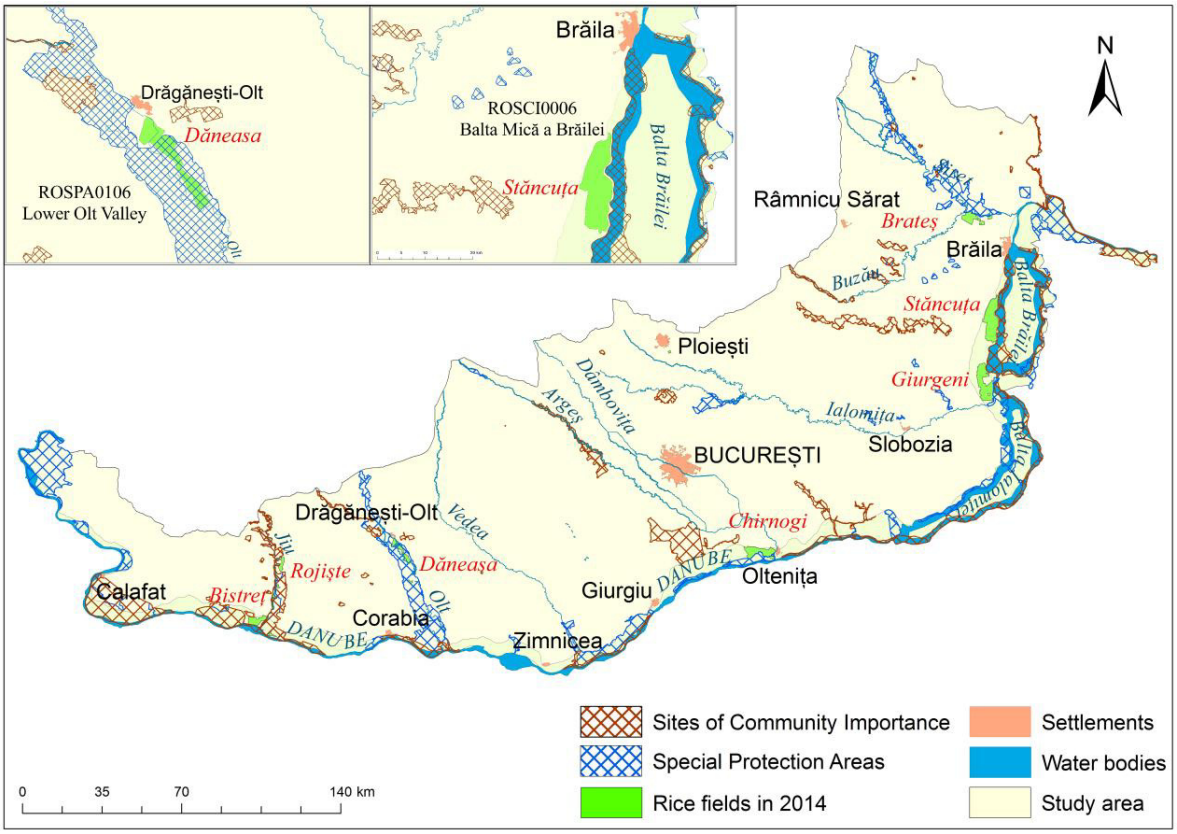

Fig. 10. The overlap between SCIs and SPAs and temporary wetlands (rice fields) in the south of Romania.

Synthesizing information from the semi-structured interviews it appears that rice fields bring a number of benefits local communities, both economically and environmentally, but unfortunately they bring a number of environmental damages unless properly managed. The reduction or disappearance of the rice fields causes biodiversity loss at the local level, thus disappearing some species of fish, snakes, insects, etc., which have their habitat in the rice fields. Local rice culture creates a certain type of agricultural landscape, with its own particular characteristics. In Asian countries, rice landscapes enjoy protection and are included in the agri-tourism circuits.

The scientific importance of our results lies in that they provide a basis for the diachronic analysis of rice-cultivated areas in the south of Romania for a considerable period (64 years), which is helpful in assessing the major changes in the Romanian rice agriculture. Thus, the old agricultural fields in the floodplains which are suitable for rice cultivation, but degraded at present (used for grazing or even abandoned), were outlined on the diachronic maps. The connectivity with protected areas was another key advantage, briefly illustrated on the map in Fig. 10. Two Natura 2000 sites overlap totally or partially with the current rice paddy fields in the study areas: ROSCI0006 and ROSPA0106. Other similar situations can be found in the floodplain areas in the south of Romania (see the

names written in red on the map in Fig. 10), but were not included yet in the present study. This issue is subject to further research.

The practical side of the study was emphasized by the positive economic importance of the rice crops at least at local level (creating new jobs, increasing the number of taxpayers, increasing the area of cultivated land), and the environmental benefits (protecting habitat integrity and hence biodiversity, the more so as the rice paddy fields overlap or border with the Natura 2000 sites). Moreover, a useful collaborative relationship could arise between the owners of rice fields and the managers of the protected sites.

Our results are consistent with the principles and findings in other studies on the importance of rice fields [9]. They analyze the economic benefits, and also environmental advantages and disadvantages [8, 9, 10, 28, 29].

4. Conclusions

The cultivation of rice was an emergent agricultural component during the communist regime (1950-1989). Although a small part of the agricultural land of Romania was suitable for rice growing, it has been exploited almost to its full potential. Two case studies came to practically support the diachronic analysis performed on the agricultural land areas in the Romanian Plain suitable for rice cultivation.

The results show a decline of rice cultivation between 1990 and 2006, associated with the transition to a market economy and misapplication of some agrarian policies on the agricultural companies specialized in rice growing in the southern regions of Romania. After 2006 until 2014, there was a revival of the rice crops (very consistent in the case study areas), spurred by the entry of foreign investors on the Romanian market in this field.

The perception of local communities in Dăneasa and Stăncuța communes on the recovery of rice paddy fields revealed a number of contradictory aspects, from the economic to those related to environmental protection, highlighting both the advantages and disadvantages of extending rice crops in the southern regions of Romania. About 75% of the respondents have noticed and sustained the positive aspects about rice crops revival, and the remaining 25% were against this process.

In the current trend, the expansion of rice fields falls into the category of modern solutions, such as the environmentally friendly recovery of degraded areas through rehabilitation and even by including them into protected areas by increasing and preserving the biodiversity. By the rehabilitation of all land suitable for rice paddies, Romania could become in the future the third largest European rice producer, after Italy and Spain.

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